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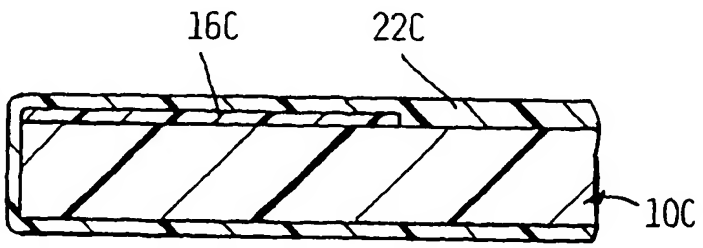
(54) Title: PROCESS FOR PROVIDING DECORATIVE IMPRINTING ON A MOLDED PLASTIC AUTOMOTIVE WINDOW PANEL



(57) Abstract: A process for manufacturing molded plastic curved automotive molded plastic window panels (10) in which a blackout (16c) and decorative border is printed on the perimeter of the panel (10) with thermally curable ink. A hard coating (22c) is applied over the panel surfaces overlying the printed border (16c) to protect the same. In order to print on the curved surfaces of the window panel (10), an ink jet process using a robot manipulator (30) is used, or a special screen printing apparatus in which a squeegee wiper (46) is mounted on a pendulum arm (48) to provide a constant angle position as the screen (42) is wiped by swinging movement of the pendulum (48). A special hinged screen frame (42) allows the frame to assume a shape in rough approximation to the panel curvature.

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PROCESS FOR PROVIDING DECORATIVE IMPRINTING ON A MOLDED PLASTIC AUTOMOTIVE WINDOW PANEL

Cross Reference to Related Applications

This application claims the benefit of copending U.S. provisional application serial number 60/140,349, filed on June 22, 1999.

Background of the Invention

This invention concerns automotive window panels. Such panels, particularly fixed panels, are often provided with a perimeter band of an opaque coating (referred to as blackout), to conceal the adhesive joint used to secure the panel in place in the body window opening.

Such blackout treatment is also used for decorative purposes for both fixed and drop windows. A fade out design consisting of a dot pattern is often used to improve the aesthetic appeal of the border.

In the past, the blackout coatings have been applied onto the glazing panel after the manufacturing steps have been completed.

Such opaque coatings have been subject to scratching during manufacturing, handling and also later when the vehicle is in use.

Molded plastic automotive glazing has long been proposed, in which a panel is molded of a suitable plastic such as polycarbonate with coating layers added to improve the performance in service of the window as to scratch resistance and resistance to yellowing from exposure to UV in sunlight. Molded plastic glazing also has used opaque coatings applied over the finished panel to provide the blackout border treatment, with the same deficiencies resulting.

Additionally, poor adhesion of many opaque coating materials to a hard coated plastic renders the borders vulnerable to excessive abrasion wear in service.

It is the object of the present invention to provide a process and window panel which makes a decorative masking border less vulnerable to scratches when handling during manufacture, or when the window is in service.

Summary of the Invention

The above recited object, as well as others which will become apparent upon a reading of the following specification and claims are achieved in applying the blackout border by imprinting directly on the molded plastic panel prior to the application of any coatings. A thermally curable ink has been found to be able to be capable of being oven cured without adversely affecting the appearance of the window panel, and is itself able to withstand the processing conditions undergone by the panel substrate during the subsequent coating processes typically applied to the window panel.

The hard coating provides a protective shield preventing abrasion of the thermally cured inks during subsequent manufacturing handling, and later when the vehicle in which the window is installed is in service.

The imprinting of the window panel is contemplated as being carried out by printing processes and apparatus which are adaptable to the curved shape contemplated for the molded plastic panels, and which printing processes are capable of imprinting a detailed fade out or other decorative pattern.

In a first approach, a special silk screen process and apparatus is employed allowing application to generally cylindrically curved panels, in which a center hinged folding frame is used to support the screen, and a wiper blade is mounted on a swinging pendulum support member. The hinging of the frame allows the screen to better conform to

the curved panel surface as the wiper blade is swept across the screen overlying the molded panel, which is held on a vacuum fixture located beneath the screen. The pendulum support enables constant angle of the wiper blade to be maintained with the screen surface as it is swept across the screen. In a second approach, ink jet printing is utilized to apply the ink, preferably by a robot manipulator on which an ink jet head is mounted, the robot manipulator executing multiple strokes with the ink jet head to apply the border pattern.

Description of the Drawings

Figure 1 is a simplified fragmentary view of an automobile body having a fixed glazing panel installed in a window opening.

Figure 1A is a perspective view of the window panel shown installed in Figure 1.

Figure 2 is a fragmentary sectional view through a glass panel having a conventionally applied opaque border treatment.

Figure 3 is a fragmentary sectional view of a hard coated molded plastic resin glazing panel having a conventionally applied opaque blackout border.

Figure 4 is a fragmentary sectional view of a hard coated molded plastic resin glazing panel having an opaque blackout border applied by the process according to the present invention.

Figure 5 is an enlarged panel section depicting the various coatings typically applied.

Figure 6 is a diagrammatic representation of a robot ink jet print head apparatus imprinting a window panel.

Figure 7 is a diagram of an ink jet stroke path used to execute printing on a generally rectangular window panel.

Figure 8 is a simplified diagram of a pendulum type screen printing apparatus used to carry out the process according to the invention.

Figure 9 is a more detailed diagram of the screen printing apparatus shown in Figure 8.

Detailed Description

In the following detailed description, certain specific terminology will be employed for the sake of clarity and a particular embodiment described in accordance with the requirements of 35 USC 112, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

Figure 1 shows a portion of an automobile body 14 with glazing or window panel 10 mounted to close a window opening 12 in the automobile body 14, typically fixed therein by an adhesive joint. An opaque black border 16 extends around the perimeter of the window panel 10, masking the adhesive joint. A surrounding frame 20 is sometimes included, surrounding the window opening 12 and panel 10. This is a typical fixed window construction.

According to the concept of the present invention, a thermocurable ink is used to print the blackout border 16C directly onto the polycarbonate panel 10C, with a hard coating and other layers 22C then applied over the imprinted border 16C, as depicted in Figure 4. The ink used must adhere to the polycarbonate material, and be properly cured by the processing used with the hard coating layer 22C, which involves oven curing at elevated temperatures, and which ink also must be able to withstand these processing conditions.

Polycarbonate window panels 10C as depicted in Figure 5, typically have several layers of coatings, represented of exaggerated thickness for clarity, which seek to

overcome the poor scratch resistance of polycarbonate material, and also to prevent yellowing by exposure to the UV in sunlight. Such coatings may include a dip coating 26 which improves hardness and blocks UV. A primer 24 is also applied to improve adhesion for bonding to the body structure. Such a dip coating process is described in U.S. patent 4,842,941.

An outer hard coat 22C further improves the hardness to be suitable for automotive service. This process involves plasma enhanced vapor deposition, and is variously described in U.S. patents 5,298,598; 5,320,875; 5,433,786; 5,494,712; 5,718,967; and 5,900,284. See also U.S. serial number 60/144,756, filed on July 21, 1999.

The step of applying the thermocurable ink is preferably carried out by a printing process such as to enable detailed decorative patterns to be produced, such as the decorative fade out mentioned above.

Two such printing approaches have been found feasible by the present inventors. The first of these is ink jet printing by use of an industrial print head 28 manipulated by automated equipment such as a suitably programmed robot arm 30, as depicted in Figure 6. A curved window panel 32 is held on a fixture 34 while the robot arm 30 strokes the print head 28 and ink reservoir around the perimeter of the panel 32, closely spaced from the panel surface (2, 3 mm), following the curved surface thereof.

The ink jets are turned on and off by the robot controls 36 at predetermined points along the motion path where the ink jet runs off the part as indicated.

Figure 7 depicts a simplified pattern in which the ink jet print head 28 is run off each corner, circling around and moved along the next side of the part, at which point the ink jet printing resumes.

This enables formation of the blackout and an intricately detailed fade out pattern 38 as shown.

A suitable ink for an ink jet and wettable to polycarbonate has been developed by Flint Ink of Ann Arbor, Michigan.

A second technique is a development of screen printing. Screen printing has heretofore been successfully applied to imprint glass windows while flat with blackout and fade out borders.

However, such screen printing has not been applied to curved panels. The molded plastic windows are contemplated as usually being of a curved shape, and hence a screen printing technique and apparatus has been developed for approximately cylindrically curved window panels. The basic arrangement is shown in Figure 8, in which the panel to be imprinted is securely held in a vacuum fixture 40 disposed beneath a folding silk screen mounting frame 42. The folding screen frame 42 has two hinge points 44 to be able to roughly approximate the curvature of the panel surface when moved out of its flat condition during the printing process.

A squeegee or wiper blade 46 is supported on a pendulum arm structure 48 pivotally supported at 49 on a frame 50.

The length of the pendulum arm structure 48 is matched to the panel curvature such that the angle of the wiper or squeegee blade to the panel surface remains constant as it sweeps over the silk screen held in the screen frame 42. The silk screen is pressed into conformity with the panel surface as the ink is forced into the panel surface by the wiper blade.

The pendulum arm length and other relationships may be made adjustable to be adapted to various part curvatures. The vacuum fixture 40 may be supported on a drawer structure to be moved out from beneath the screen frame 42 for loading and unloading.

Suitable silk screen thermally curable inks are commercially available, such as Noristar PG948, Noriprint PS 948, and Thermojet 948.

Figure 9 diagrammatically depicts further details of the screen printing apparatus depicted in Figure 8.

The frame 50 supports a shaft 52 on which a support block 45 for the pendulum pivot 49 is slidably adjusted up and down thereon by a hand wheel 51 and threaded shaft 53. A pendulum swing drive 59 can be provided for powering the swinging of the arm 48 during printing.

The squeegee bar 46 is extendable down on the pendulum arm 48 by an air cylinder actuator 56 (which also can be set to exert proper pressure on the screen 60 clamped in folding screen frame 42).

An angle adjust mounting 64 allows the squeegee bar angle to be selectively set.

The flood bar 66 is mounted to one side of the pendulum arm 48 and can be lowered by an actuator 68 when the squeegee bar 46 is raised and traversed across the screen (when the frame 42 is in its flattened condition) by a traversing drive mechanism 70. The flood bar 66 is raised and retracted to one side when not operative to allow the swinging movement of the pendulum arm 48.

The folding screen frame 42 has a center section 72 hinged at each end to a left and right wing section 74, 76.

An actuator 78 positions the center section 72 against a stop 80 when raised, wings held against stops 82, 84. The center section 72 is lowered to an adjustable lowered position by the actuator 78, also causing lowering of the wings 74, 76.

Wing adjustment mechanisms 86, 88 allow accurate setting of the wing section lowered printing positions, adjusted to achieve proper printing. It should be understood that dual adjustment mechanisms 86, 88 are used with each wing section 74, 76 at

the front and the rear, operated synchronously to insure parallel positioning of each end of each section 74, 76.

The vacuum fixture 40 which holds a panel 64 (in a recess 66 in the fixture 40), can be rolled in and out on support/roller structures 90, 92. An elevating actuator mechanism 94 allow the fixture 40 to be raised to a printing position just below the screen frame 42 in its lowered, folded position. Automation is readily adoptable to loading and unloading of the part 64 with the roll out mounting of the vacuum fixture 40.

Claims:

1. A process for forming an automotive window panel adapted to be installed in an opening in an automotive vehicle body structure, said process including the steps of:

molding a transparent panel from a synthetic resin configured to be fit in said body structure opening;

printing an opaque blackout border about a perimeter of said panel; and

thereafter depositing an abrasion resistant hard coating over the surfaces of said panel, said hard coating overlying said opaque border, whereby said hard coating serves to protect said opaque band.

2. The process according to claim 1 wherein in said molding step, said panel is molded from polycarbonate.

3. The process according to claim 2 wherein in said step of printing an opaque border on said panel, a thermally curable ink is utilized.

4. The process according to claim 3 wherein said step of depositing a hard coating onto said panel surfaces including the steps of causing a plasma enhanced reactant material to be deposited onto said panel in a vacuum chamber.

5. The process according to claim 1 wherein a decorative fade out pattern is printed adjacent said blackout border.

6. The process according to claim 1 wherein said printing step is carried out with an ink jet moved over a curved surface of said panel perimeter.

7. The process according to claim 1 wherein said printing step is carried out by a silk screen process in which a squeegee bar is moved over a curved surface of said panel perimeter.

8. An automotive window panel made by the process of claim 1.

9. An automotive window panel made by the process of claim 2.

10. An automotive window panel made by the process of claim 3.

11. An automotive window panel made by the process of claim 4.

12. A process of applying an opaque blackout border on an automotive molded plastic panel, including the step of printing an opaque blackout border onto a perimeter of said panel with a thermally curable ink.

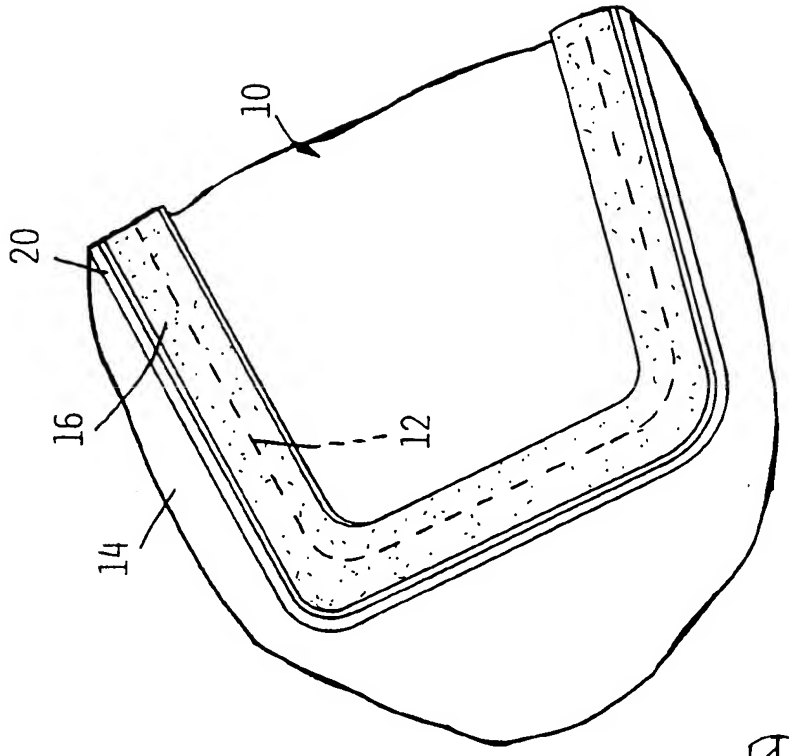

FIG. 1

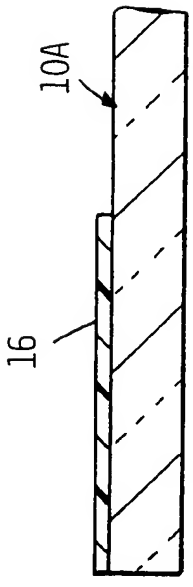

FIG. 2
PRIOR ART

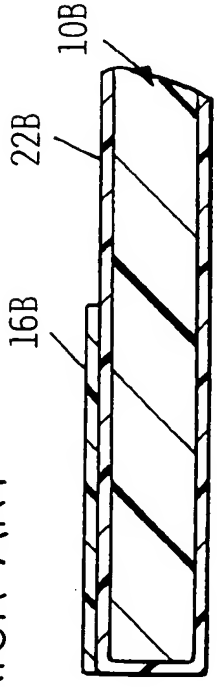

FIG. 3
PRIOR ART

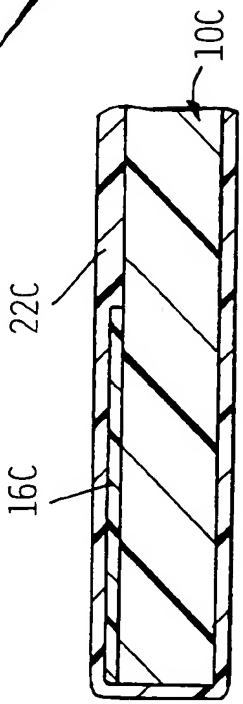

FIG. 4

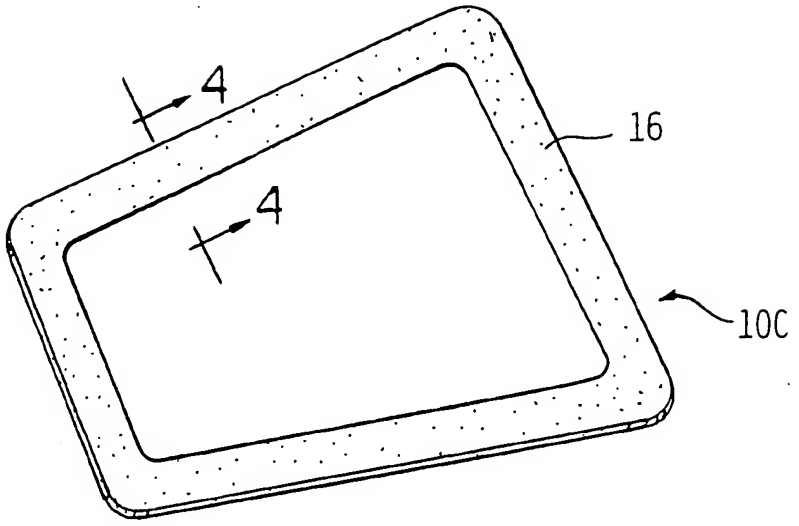

FIG. 1A

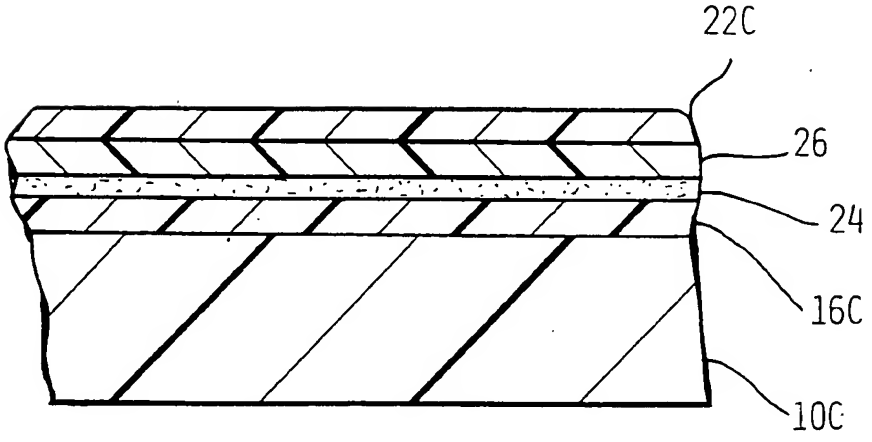

FIG. 5

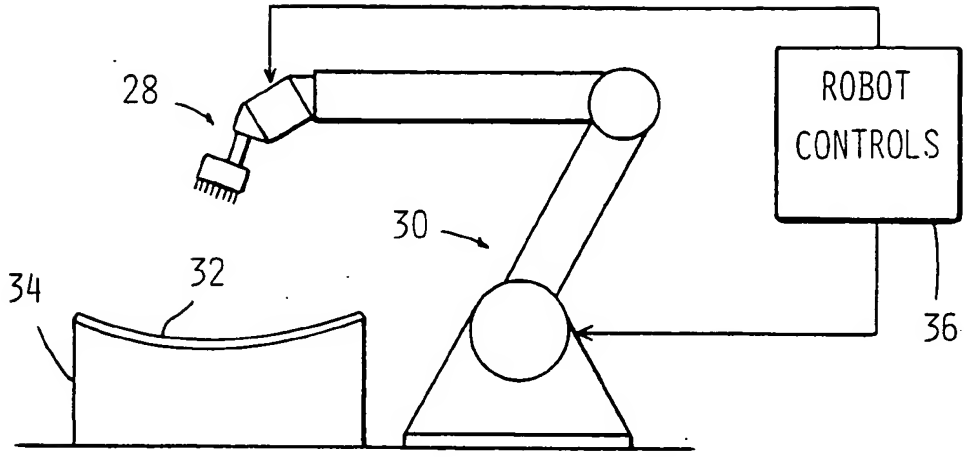

FIG. 6

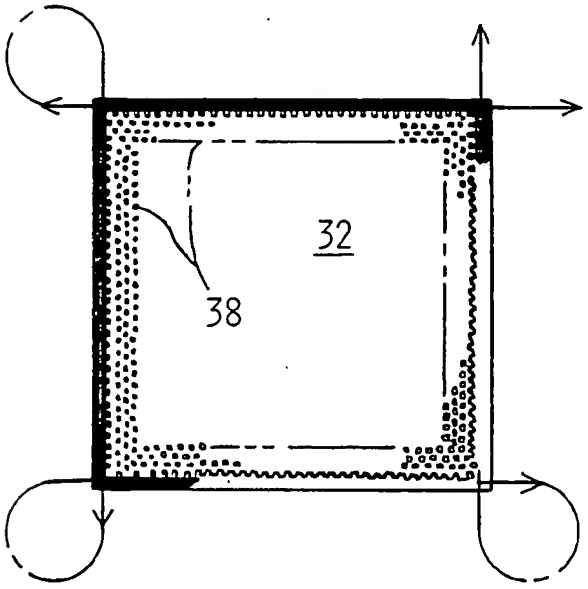

FIG. 7

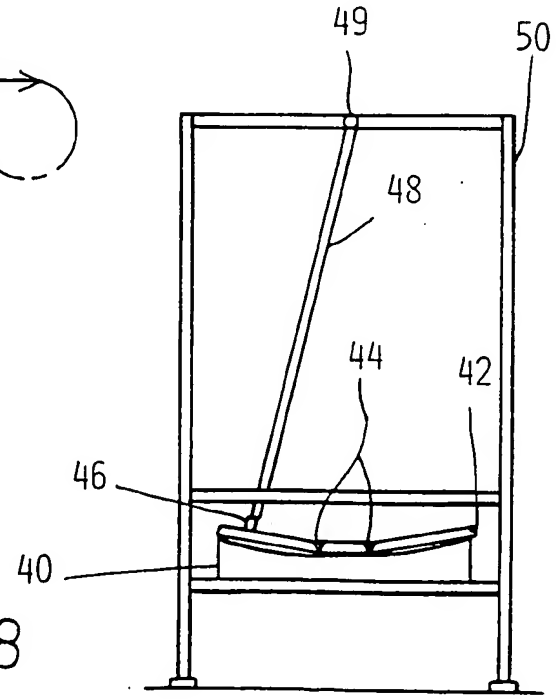

FIG. 8

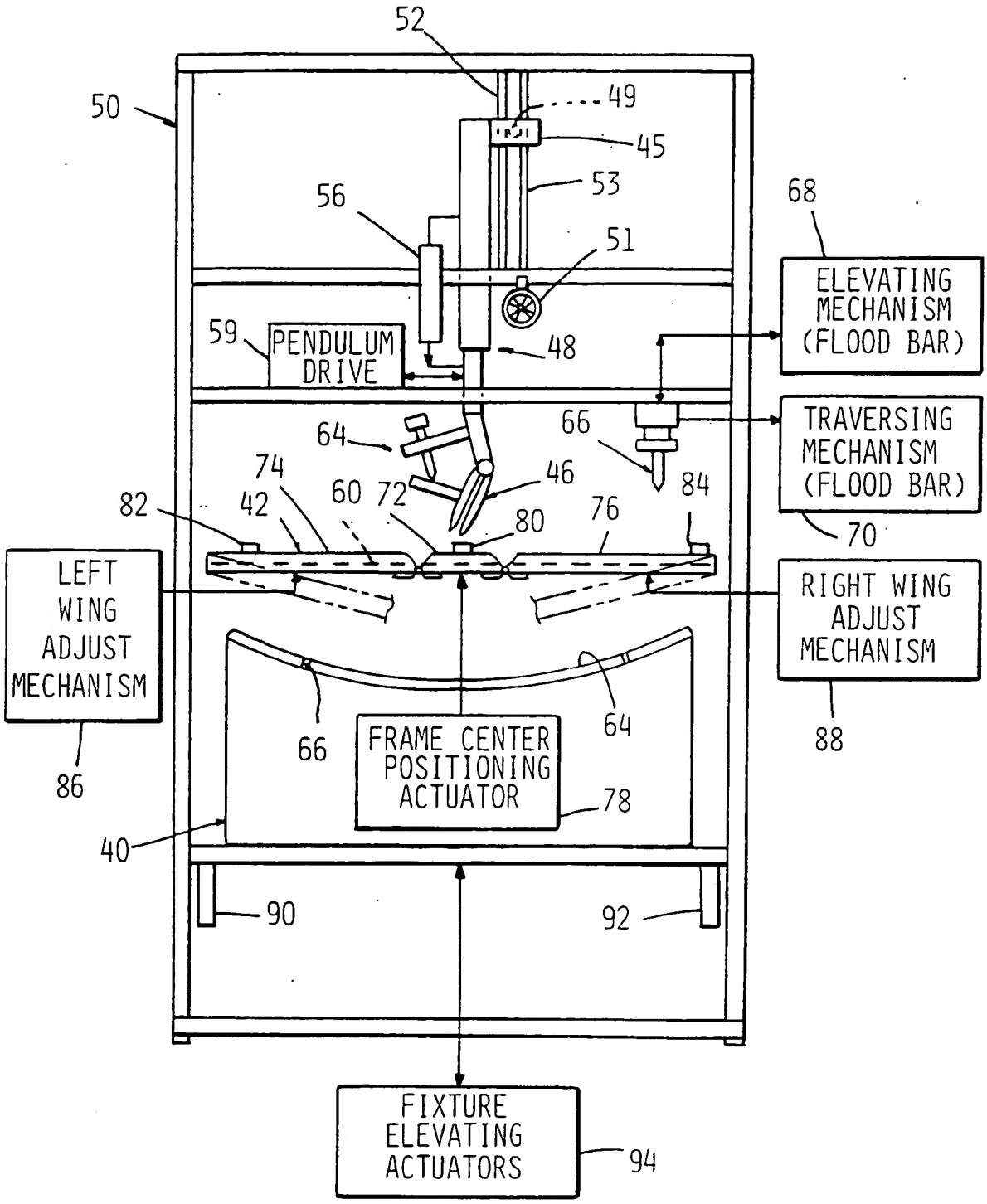
52
50
49
45
53
56
68
51
ELEVATING MECHANISM (FLOOD BAR)
59
PENDULUM DRIVE
48
64
66
TRAVERSING MECHANISM (FLOOD BAR)
74
46
60
72
84
82
42
80
76
70
LEFT WING ADJUST MECHANISM
RIGHT WING ADJUST MECHANISM
66
64
FRAME CENTER POSITIONING ACTUATOR
86
88
78
40
90
92
FIXTURE ELEVATING ACTUATORS
94

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/17187

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B29C 41/20; B60J 1/00; E06B 3/00
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 52/208; 264/132, 134, 246, 247, 271.1, 279.1, 511, 571; 296/146.15

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,895,859 A (YOSHIDA et al) 22 July 1975, see entire document	1-12
Y	US 5,189,952 A (OHMURA et al) 02 March 1993, see entire document.	1-12
Y	US 5,887,393 A (VANARK et al) 30 March 1999, see entire document.	1-12
Y,P	US 5,915,780 A (KOBREHEL et al) 29 June 1999, see entire document.	1-12
Y,P	US 5,962,083 A (HATANAKA et al) 05 October 1999, see entire document.	1-12
Y,P	US 6,000,814 A (NESTELL et al) 14 December 1999, see entire document.	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

52/208; 264/132, 134, 246, 247, 271.1, 279.1, 511, 571; 296/146.15